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ORCHARD PRIMERS

No. 1

PLANTING

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ORCHARD DEVELOPMENT

No. 1—PLANTING

(Revised Edition)

That it might offer to its patrons in the territory which it serves, the benefits of scientific research and improvement in methods resulting from careful study and experiment, The Pennsylvania Railroad Company arranged with Prof. H. A. Surface, Economic Zoologist of the State of Pennsylvania, to prepare for distribution through its agencies, this practical treatise on "orchard development". The following pamphlet devoted to **Orchard Planting** is one of four which might be termed "Orchard Primers", the others being devoted respectively to **Cultivation, Pruning** and **Spraying,** copies of which can be had upon application to the parties designated on the cover, or to the Freight Agents at the various stations.

The Pennsylvania Railroad Company has also issued pamphlets dealing with the growing of "Alfalfa", "Fertilization of land by the proper use of lime", "Seed Grain Suggestions" and "Potato Culture", copies of which may also be secured upon application to the parties above referred to.

March 1st, 1911

INV. '60

PLANTING AN ORCHARD

PROPER PLANTING is essential to success in fruit culture. **CHOICE OF LOCATION** is the first important step; this selection involves **SOIL DRAINAGE** and **AIR DRAINAGE.**

SOIL DRAINAGE. Trees planted in damp soil in valleys or near water make rank growth, unfavorable to fruit production. Trees in soil habitually wet do not thrive. The best site is one naturally drained or where tile drainage is possible.

AIR DRAINAGE is more important than water drainage. The warm air rising from valleys is displaced by cool air moving down from higher ground. Air in pockets or valleys stands still, inviting frost in late Spring and early Fall; hence, orchards devoid of good air drainage experience frequent fruit failures in consequence. This applies most to delicate fruits, such as peach and plum. For these, elevated land should be chosen, meaning land sufficiently above its surroundings to permit the air to drain from it to lower land adjoining. Elevated orchards with good air drainage are least injured by plant diseases and certain insects; make less rank growth; produce better fruit; and demand less spraying and pruning, than those on lower land, particularly where the latter's air drainage is poor.

CHARACTER OF THE SOIL. For Apple and Pear, limestone soil is ideal; for Peach and Plum a loose soil, such as sandy, shale or slate loam, is best. For all fruits a deep soil is important. The deeper the soil the more moisture can be retained for use in development and ripening during the critical summer period. Do not plant fruit trees on shallow soil nor on hill sides so barren that moisture and soil fertility cannot be retained.

PREPARATION OF THE SOIL. This should be similar to that required for a good corn crop, other conditions being ideal. If, however, tile drainage is needed, lay the tile laterals at least two rods apart, locating the tile between the tree rows rather than under the trees, to prevent tree roots from filling the tile, and to facilitate repairs and avert danger to trees in repairing tile drains.

SUB-SOILING. This consists in following the plow in the plow furrows, with an implement called a subsoiler, the effect of which is, to reach greater depth than the plow, loosen the sub-soil and without turning it out of the furrow, opening it to the better passage of moisture and air, and penetration of tree rootlets, rendering possible a greater production and retention of plant food. Sub-soiling is not needed where a deep soil, having proper natural under-drainage, exists; but where a stiff sub-soil is encountered, it is advisable to break it up with the implement referred to before planting the orchard. The crop previous to tree planting should be corn or potatoes, avoiding the use of heavy sod ground. Plow the ground in the Fall and then run through it late in Fall and early in Spring with a spring tooth harrow. Cultivate again in the Spring, using a disc harrow or a spring tooth harrow, or plow again in the Spring and then prepare as for corn or potatoes.

VARIETIES. This is important. Those who planted the older orchards made the fatal mistake of planting so many varieties that a sufficient quantity of one kind was not produced to interest buyers, who invariably desire car lots. The selection is therefore governed by whether the purpose is to plant a home orchard or a commercial one. If the home orchard is wanted, plant a few trees of each of several varieties, so selected as to yield a succession of fruit of good quality, from earliest to last, thus prolonging the time of consumption. If a commercial orchard is desired, select a few standard varieties that have been tested and are known in the section where planted to thrive best, and which possess qualities that appeal to buyer and consumer and admit of harvesting, shipping and delivery at destination in attractive condition. Some varieties excellent for home use are undesirable for commercial purposes, because too delicate to ship well, or must be too promptly handled to reach desirable markets in best condition, or while faultless in flavor are too small in size or too light in color to attract purchasers.

FOR HOME APPLE ORCHARDS, in Eastern and Southern Pennsylvania, the following are suggested: Yellow Transparent, Early Harvest, Red Astrachan, Duchess, Summer Rambo, Maiden's Blush, Wealthy, Smoke House, Grimes Golden, Rome Beauty, Jonathan, Stayman's Winesap, York Imperial, Paragon and Bonum; for the more elevated and Northern parts of the State, the King, Gravenstein, Baldwin, Northern Spy and Rhode Island Greening are standards.

FOR COMMERCIAL APPLE ORCHARDS, in Central, Eastern and Southern Pennsylvania, Summer Rambo, Smoke House, Stayman's Winesap, Grimes Golden Rome Beauty, Stark, Paragon and York Imperial are a good selection, while for the elevated and Northern sections, the Northern Spy, Baldwin, Greening and King are good.

In commercial planting of **PEACHES,** the **WHITE VARIETIES** recommended are: Carman, The Champion, Mountain Rose, Old Mixon Free, Fox's Seedling, Iron Mountain and Heath Cling; while among the **YELLOW VARIETIES,** the Elberta stands first with Chair's Choice, Late Crawford, Beer's Smock (or Geary) and Salway following. The last named is suited only to elevated

sections. The earlier varieties are most subject to rot; the yellow varieties are preferred commercially, while white varieties have better quality and are most desirable for home use.

ORDERING TREES. It is not necessary to seek stock in the extreme North or South to obtain hardy and healthy trees or those that are for any reason better than trees grown in our own State. Hardiness of the tree depends upon the variety, the soil, locality where planted, and care given after planting, rather than on locality of nursery where started. In ordering observe the following rules:

1st. Order from any reliable nursery.

2nd. Avoid tree peddlers, tree dealers and unknown agents.

3rd. Prepare and send your list to various reputable nursery men for estimates of prices.

4th. Order one-year-old trees of all kinds; accept none older, except Pear and Apples trees, which may be two years old.

5th. Specify that there must be no substitution of varieties for those ordered, without your consent.

6th. Order trees either unpruned, or with heads started low, not above 2½ to 3 feet above the ground.

7th. Specify the latest date at which trees must reach you, and be prepared to care for them promptly upon arrival.

WHAT TO DO WHEN TREES ARRIVE. Observe three points to induce tree growth, as follows:

1st. Keep the roots damp.

2nd. Prune branches severely at time of planting. Shorten long, deep and broken roots.

3rd. Plant properly by packing the earth well about the roots.

Upon arrival of trees at freight or express station, remove at once to your premises, unpack, sprinkle the roots with water, and cover, until planted or properly stored for planting. It is vital to exclude wind and sunshine from the roots for even a short time. If roots or tree appear dry when received, bury the entire tree in damp soil for two or three days, or plunge the roots into a tub of thin mud. When trees are unpacked they should at once be heeled into a trench prepared and waiting for them. After the soil is packed about the roots it may then be wet, but not before. In heeling trees into the ground pending the time for planting, their roots must be well covered with damp earth; if this be done in cultivated ground where there are no mice, you can follow with a further protection of strawy manure. If trees be received when ground is frozen or too wet to admit of heeling in, they should be unpacked and placed in a damp cellar, their roots packed in the material in which received, and then sprinkled well with water and covered with old carpet, burlap, sacking, or other cloth material, and water thrown over them as often as the least evidence of roots becoming dry is observed. Frequent inspection as to this is suggested. A large stock of trees was kept by the writer all Winter in an ordinary cellar by this method, and 98% of them grew when planted in the Spring.

INSPECTION FOR PESTS. When trees arrive it is always advisable to inspect them when unpacked to determine if in good condition, and free from pests. Open packages in the presence of witnesses, and if contents are found seriously faulty there will then be proof of the complaint. If trees are not in proper condition, or unsatisfactory, they should be properly repacked and returned at once, or at the time they are received they should be heeled into the ground, as directed in this section, and the shipper, seller, and grower should be notified. Trees, being perishable, should not be allowed to remain at the station, or in the packages in which received, but should be given proper care, even though they may be returned later on.

When removed from packages trees should at once be examined for pests with which they may be infected, such as the following: **THE SAN JOSÉ SCALE.** This is the smallest injurious insect found on nursery stock. It appears about the size of the period in this print. The bark around it may be colored red, and thus facilitate its detection. If the insect is alive it can be seen through the microscope as a plump, lemon-yellow body beneath the brown over-turned scale when the latter is raised with a pin point. If dead it will be dark and shriveled. This pest can be killed by dipping the trees to the roots (but not covering the roots), after pruning, in a barrel of Lime-sulphur prepared just as for spraying for San José scale. All packages of deciduous nursery stock should bear certificates that they have been fumigated. If properly done, this insures freedom from living insects.

The most serious pests that can be imported on nursery stock are the **BROWN-TAIL** and **GIPSY MOTH.** The Brown-tail Moth will be found to be a very small, brown, hairy caterpillar, or worm, in loose web-like tents two or three inches long, and quite conspicuous. It is only necessary to remove and burn both them and the packing material. The Gipsy Moth will appear in the form of a mass of eggs, readily detected, and these should be removed and burned, together with the packing material.

"THE BORER" is the most serious insect enemy of peach and plum in Pennsylvania. It occurs in holes which it makes in or near the roots, and can be detected by gum exuding from the tree and containing fine, grain-like sawdust. The borer is not deep beneath the bark of nursery stock, and can readily be removed with a pin or pointed knife blade. The trees are not injured if it is found and removed before planting, but it may prove fatal to plant the tree without removing it.

CROWN GALL, or **ROOT GALL,** also called **HAIRY GALL,** is very common upon nursey stock. This is present in the form of knots or galls on the roots or at the crown, and at these places abnormally dense branches of fine hairy roots occur. Trees so infested should be rejected, or planted by themselves if retained. In ordering trees specify that they must be free from Crown Gall, Root Gall or Hairy Gall, and then reject any trees that arrive not free from it. It is not known how serious are the results of this disease, but in some cases it is fatal, or may seriously weaken and stunt the trees.

PLANTING. Proper planting is essential to good results. Trees improperly planted are seriously stunted, many may die, and consecutive replanting results in an irregular orchard of trees of various sizes and ages. In replanting, it is often impossible to determine, before bearing, the original variety; and any failure of uniformity results in inconvenience at time of harvest.

To secure best pollenizing of apples and pears the planting of large blocks of one variety alone should be avoided. Plant four to eight rows of one variety, followed by four to eight rows of another and then repeat the first or some other variety, to create an orchard consisting of rows of varieties, rather than solid blocks; and thus secure greatest cross fertilization and insure better setting of the fruits.

Other fruits than pears and apples need not be divided and planted in strips for pollenizing of fruit, but for convenience in harvesting can be better planted in solid blocks.

DATE OF PLANTING. Trees well set in the Fall usually make growth enough within three years to overtake trees set in late Spring of the same year, but as between Fall and Spring planting, the difference in results is not sufficient to justify delay for Fall planting. The earlier you plant in the Spring the more insured is the growth and better the results. This is signally true of cherry trees. Trees kept in storage and remaining dormant can be planted much later and are more sure of living than those whose growth has started.

DISTANCE OF PLANTING. Think of them as fully grown trees, far enough apart to permit the air to move between them, and to admit of the use of apparatus in spraying or of wagons when harvesting fruit. Modern planting requires greater distance between trees than under old methods. The distance is governed by the size trees will grow, and this is governed by their kind and variety, and the nature of the soil in which they grow. On the average soil of Pennsylvania planting should not be closer than the following:

Apple trees, thirty-six feet; Peach and Plum, eighteen feet; Pear, twenty feet; Sweet Cherry, twenty-five feet; Sour Cherry and Quince, fifteen feet.

On a light or very dry soil, or on hill sides, where growth will not be so great, the distance can be reduced by about 10% for each; while on soil that is rich or damp, the distance should be increased at least 10%. All trees should be planted with a view to cultivation in each direction, where the lay of the land permits.

METHOD OF PLANTING. After preparing the soil as for corn or potatoes, and trees are at hand ready for planting, the rows should be marked by scoring with a heavy plow, running a furrow as in breaking the soil. The plow should then be returned in the same furrow to deepen it and throw the soil in the opposite direction. Make these furrows as far apart as the trees are to be planted, measuring the distance with accuracy, and running the furrows straight. Across these deep furrows make shallow marks by dragging a log chain, as far apart as the trees are to be planted in that direction, which, with the square system, would be the same distance as the deep furrows were made. While the soil is yet fresh, and in the condition of moisture and fineness just right for planting corn or potatoes, the planter should follow the shallow score marks across the deep furrows, with a boy or other attendant to drop trees before or hand them to him as he plants. If trees have, previous to planting time, been divested of broken or extra long roots, and "heeled in" in bunches at various points across the field for use as needed, a boy can handle and drop them fast enough for two planters. Never leave trees exposed on the ground longer than a few minutes. Avoid exposure as far as possible. The planter should remove lumps of earth, stones or dry earth from the point of intersection of the score marks, and, if necessary, deepen the furrow with his spade, so that a little fine, loose, moist earth may be thrown on the bottom upon which the tree is to rest, the depth to be regulated by filling or deepening the furrow so that the tree will be planted an inch or two deeper than it grew in the nursery. Seizing the tree in his left hand, the planter should press it

firmly down upon the loose soil provided, quickly spreading the main roots to their allotted positions with his right hand, and sighting up and down each furrow or score mark to see that the tree stands exactly in line. Loose damp earth should then be shoveled or kicked over the roots to a depth of not more than two or three inches, and then tramped firmly around the tree, holding it upright between the feet and turning entirely around it in the process of tramping. The dryer the soil the more firmly it should be packed close to the roots. It can not be tramped too hard when not too wet. A shovel full of loose soil should next be thrown upon that which has been tramped, and the planter is ready to pass on to the next intersection of furrows and plant the next tree in the same way. At any time after the row is planted the soil can be turned to it, and the filling be completed by the use of the plow, or by hand, as desired. This saves time and expense. The pruning can also be done with economy immediately after rather than while planting. Under this system all the planter carries is his spade, and he is able to plant almost half as rapidly as a man would walk across the field. If the tree proves to be but a little out of line, a foot or less, this makes no difference, as within a few years the action of the wind and other causes will eliminate this slight irregularity. If, however, a mistake occurs and the tree proves to be conspicuously out of line, more than a foot, it is better to correct this at once.

PLANTING FILLERS. Many growers desire to utilize the ground by growing some fruits in that which must later on be occupied by the full grown standard trees. The trees which are planted in such space, with the design of removing them before they crowd the standards, are commonly called "fillers." It has been the custom with many planters to use peach as fillers, planted each way between apple trees; but owing to the difference in methods necessary in cultivating and spraying peach and apple, and also to the fact that the curculio, which makes wormy peaches and knotty or imperfect apples, is much worse on apples where peach have been planted as fillers, and further that the fillers must be removed at a time when the living peach trees could be renewed by merely topping or "dehorning," it will not prove desirable to rely upon peach as fillers in apple orchards.

The best writers and experienced growers now assert that it is more desirable to plant as fillers some young-bearing variety of apple, such as Yellow Transparent, Wagener, Wealthy, York or Jonathan, and plant the peach orchard if desired elsewhere by itself.

Most of the standard varieties, excepting Northern Spy and Baldwin, are young bearers and can themselves be planted in solid blocks, using their own varieties as fillers in each direction, with a view to cutting out every other one each way, or in other words, three-fourths of them, as soon as they become large enough to crowd trees that are to remain permanently.

It requires courage, determination, and apparent recklessness to cut out fillers, and hence it is generally not done soon enough. For this reason, orchards with fillers are liable to reach much worse conditions than those without them.

PLANTING DWARFS. The planting of dwarf trees has been unduly recommended. They are all right for ornamental purposes, and may fairly serve as fillers among standards, but recent experience has shown that an orchard of dwarfs is not to be considered in comparison with an orchard of standard trees that will bear young, such as Yellow Transparent, Wagener, Wealthy and Jonathan. Among pears, the Duchess is the best dwarf variety, and may under certain circumstances yield good returns.

Immediately after planting the tops should be severely pruned. (See companion Booklet on **PRUNING.**) When planting in the Fall it is best to mound the trees well to prevent loosening by wind, winter freezing below the bud or graft, and especially gnawing by mice below the bud.

For those who desire to pursue the subject further, the following text books are suggested:

American Fruits	*Downing*
The American Fruit Culturist	*Thomas*
The American Apple Orchard	*Waugh*
Principles of Fruit Growing	*Bailey*
Lessons in Fruit Growing	*Goff*
Plums and Plum Culture	*Waugh*
Dwarf Fruit Trees	*Waugh*
The Pruning Book	*Bailey*
Insects Injurious to Fruits	*Saunders*

Bulletin 178, Office of Experiment Stations, U. S. Department of Agriculture, contains list of important references on Fruit Growing. costs 20c. Apply to Superintendent of Documents, Washington, D. C.

"Fruits for Pennsylvania," Funk, Bulletin 152, Pennsylvania Department of Agriculture, Harrisburg, Pa.

Monthly and Quarterly Bulletins by Prof. H. A. Surface, State Zoologist, Division of Zoology, Department of Agriculture, Harrisburg, Pa.

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ORCHARD PRIMERS

No. 2

PRUNING

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No. 2—PRUNING

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March 1st, 1911.

PRUNING AN ORCHARD

The proper pruning and training of a tree is fully as necessary, to obtain satisfactory results, as is the training of a child. Every person growing trees should have in mind the purposes, principles, and methods of pruning. One of the greatest afflictions of the orchards of this State has been the atrocious work of the "tree butcher". Too many trees have been pruned by the "cow-tail" method, by which both fruit spurs and small branches have been removed, leaving only tufts of twigs at the ends of long branches.

When a tree is badly injured by any cause, especially the San José scale, the first step should be to prune it thoroughly. A fundamental principle in all pruning is to cut back every injured tree in proportion to its injury. This should be done without regard to the nature or cause of the trouble. It is because a tree, when healthy, forms many more buds than it can properly carry to maturity in its injured condition, and every effort to develop and protect the superfluous buds detracts from the vitality or vigor that should go to the other buds.

Remember that when a tree is injured by San José scale this injury is much more severe than is at first apparent. In fact, it may be so extreme that there is no possible chance to revive that particular tree, and in such case the only thing to do is to remove it, in order to start a vigorous tree where it was, as soon as possible. There may be considerable life in the trunk and large branches, in which case it can be topped or "dehorned", and may throw out extra branches, known as "water sprouts". Peach and plum trees can be topped back completely to the

trunk and be made to grow a good top, which will bear a good crop of fruit the second summer afterward. Such severe pruning of apple and pear trees does not always result in success.

Objects in Pruning: In pruning, the operator has in mind one or more of several purposes, such as the following:

1. TO REMOVE DEAD, DYING AND BROKEN BRANCHES. The first step in pruning is to remove all dead and superfluous wood. A skillful pruner endeavors to remove the dead branches first of all. Next he removes those that are dying or crowding, and trims and shapes those that are broken.

2. TO REMOVE LIMBS WHICH CROSS AND ARE LIABLE TO CAUSE INJURY TO EACH OTHER BY FRICTION OR RUBBING. When one branch rubs another by action of the wind in the tree-top, such branches are weakened, and disease germs, such as canker blight and bitter rot blight, may find entrance there. It is best to cut out crossing and rubbing branches as soon as observed.

3. TO REMOVE LIMBS THAT ARE GROWING TOO CLOSE TOGETHER AND COMPETING WITH EACH OTHER FOR THE SAME SPACE. Frequently limbs are seen running parallel and apparently trying to occupy the same position. If the poorer of these be removed, it will give vigor and freedom to the better and remaining one, and will insure healthier foliage and fruit. In almost every tree-top it is possible to illustrate the removal of one or more branches that are crowding too closely in their apparent effort to occupy the same position. Every branch should have its own space to occupy, and should be uncrowded by its neighbor. Pruning to bring about this result is recommended, and will give open heads and insure more healthy leaves and better colored fruit.

4. TO CUT BACK LIMBS WHICH HAVE GROWN TOO STRONGLY AND TEND TO OVERBALANCE THE TOP OF THE TREE. It is often noticed that for some cause one or more branches have grown to remarkable length and are beginning to produce an unsymmetrical or overbalanced top, such as the expert fruit grower desires to avoid. It is best to take this in the start by cutting back such extremely long twigs, and making sure that the top grows in the general form desired, according to the ideal shape in the mind of the pruner. A well-balanced tree-top gives greater insurance against splitting and breaking at a critical moment, whether due to the effects of a heavy crop, wind, ice, or other cause.

5. TO CUT OUT BUSHY GROWTH OR TWIGS, OR THIN THE TOPS. This becomes very important in order to make it possible to do perfect spraying as well as for the purpose of getting rid of a number of superfluous buds which can never make much growth and cannot do much else than sap the vitality of the tree. It also opens the top of the trees to let in the air, light and heat and give ventilation and sunshine, which assures greater freedom from diseases of leaf and fruit, and also insures better coloring of fruit. A top that is dense with brush cannot be well sprayed. When a tree is infested with San José scale it is like a man who is sick and in need of every condition favorable to his recovery.

6. TO HEAD BACK TREES OR BRANCHES THAT ARE GROWING TOO TALL WITHOUT BRANCHES, AND THUS TO CLOSE OPEN SPACES, FORM LOWER BRANCHES OR KEEP THE TOPS DOWN. In this day, when spraying is necessary, it becomes likewise essential to prune in such a manner as to force the head of the tree down low, instead of making it higher. Thus, the skillful operator will not cut off the lower branches, but will remove those that are too high. The great objection to the old style trees is that they are entirely too tall for modern methods, and the fruit grower of the future who best succeeds will be the man who prunes in such a manner as to make low spreading tops. This will make it possible for him to spray his trees from the ground or from carts, thin his fruit from the ground or the step-ladder, and pick it from a position that will be convenient for himself, and do away with the loss of time and bruising of fruit by climbing tall trees and high ladders.

7. TOPPING BACK LONG SHOOTS OR BRANCHES causes them to throw out side branches and thus they are forced TO DEVELOP SHOOTS AND BRANCHES WHERE WANTED in order to fill up any gap that should be closed to make a proper and symmetrical top.

8. TO CHECK GROWTH THAT IS TOO VIGOROUS TO PRODUCE GOOD FRUIT. Everyone has noticed that where trees grow in low, damp, rich soil, they continue to make vigorous growth for many years, without setting or bearing fruit, while the same kind of a tree, of the same age, on a poorer and drier soil, has been bearing crops for years. The fact is that strong growth and heavy fruit-bearing cannot occur at the same time. Pruning often checks growth and insures fruit. An old and justifiable saying among fruit growers has been, "prune when the trees are dormant to promote woody growth, and prune when they are in leaf to check growth and set fruit buds." When a tree is growing too vigorously, without bearing, it is well to prune it back to some extent, grow grass or some other crop around it, fertilize with phosphoric acid or potash, but not with nitrogen, and thus check its growth, but promote its fruiting.

9. TO STIMULATE GROWTH AND INCREASE THE VIGOR OF THE TREE. This is the main point and purpose in pruning a scale-infested tree. Such a tree may be striving to bring ten thousand buds to perfection, and really not have life enough to develop properly over a thousand. If then nine-tenths of the branches and buds be cut away, the life that would have gone into them is concentrated in those remaining, and the tree thus becomes much improved in vigor. By severely pruning a weak tree it can be made to concentrate its growth in a few shoots or branches, and thus to carry itself over a period when, to attempt to scatter its growth through many more branches, twigs and buds, would mean to devitalize it by exhaustion and cause it to die. For example, the peach tree that is severely cut back or topped, will be given a new lease of life and will form a new top, often setting fruit buds for the next year's bearing, while the same kind of a tree, of the same size, in the same condition, near at hand, left unpruned, is liable to continue to decline and soon die. In Downing's book on "American Fruits" he emphasizes again and again the statement that "pruning is manuring." This means that severely pruning back a weak tree, while it is dormant, puts more life and growth into branches and buds that remain.

10. TO REMOVE BRANCHES OF UNDESIRABLE VARIETIES FOR THE PURPOSE OF TOP-WORKING OR TOP-GRAFTING, THE TOPS OF TREES OR PARTS OF THEIR TOPS ARE OFTEN CUT AWAY BY PRUNING. This is merely mentioned as one of the incidental purposes of pruning, which should not be omitted in a brief review of the entire subject.

11. TO DIRECT AND SHAPE THE GROWTH OF THE TREE AND DEVELOP THE IDEAL TOP DESIRED BY THE OPERATOR, young trees should be pruned, just after they are planted, and again a year later. Most persons err in not pruning enough, while others make the mistake of cutting and pruning more than is necessary, and thus waste time in forcing the tree to exert too much energy in growing wood to be thrown away. In pruning for the purpose indicated, the idea is, to develop a symmetrical top of such form as the operator desires, but which should be very low and widespread, rather than tall and narrow.

12. TO CAUSE YOUNG TREES TO GROW WHEN TRANSPLANTED THEY SHOULD BE PRUNED SEVERELY. The best results seen with peach trees are when they are cut off just below the nursery tops, or about a foot and one-half above the ground, at the time of transplanting. This seems barbarous, but is beyond doubt the best means of invigorating the tree and forcing its growth. Young orchards of good size, which would otherwise be in good condition, are seen perishing because the planter did not have the nerve to cut them back severely when planting. With apple and pear the pruning should likewise be severe, but the stubs of branches which are to be the primary forks of the grown tree may remain, although if the tops are too high it is best to cut them entirely off at the desired height at time of planting. Thus the ideal skeleton system should be outlined in pruning the tree when first planted, or at the latest, a year later.

13. ONE IMPORTANT PURPOSE IN PRUNING A TREE THAT IS TO BE SPRAYED IS TO REMOVE AS MUCH SUPERFLUOUS WOOD AS POSSIBLE, not only for the purpose of making it easier to get the nozzle and the spray rod into and around the tree tops, but also to shorten up long and very tall branches, and save the material and time of the operator. Any branch extending to such height or distance that thorough spraying to its very tip is impossible should be cut off, rather than left unsprayed with living scale upon it, which will subsequently extend and cover the other portions of the tree.

DATE OF PRUNING: When pruning is intelligently and properly done the exact date is not important. A prominent fruit grower said "Prune whenever your knife is sharp, and keep the knife sharp all the time." By this he meant that he walked among his trees and watched them, and whenever he saw a small twig developing out of place and liable to become a branch, where not wanted, he cut it off before it reached such size as to require amputation with a saw. This is proper pruning. Watch and direct the growth of the tree, cutting out small branches, or rubbing off buds here and there, rather than give the tree a triennial overhauling. or cutting it severely every three years or more.

If there are large branches to prune, they can, if dead or dying, be cut out at any time, but if they are healthy it is better to cut them out during the dormant season, and the best time for this is in the very early spring. Thus, where there is severe pruning to be done the dormant period is best, but this can be done properly in either winter or spring. However, it should not be necessary to amputate large limbs from trees.

In cutting off limbs larger than a half inch in diameter, it is advisable to paint them with some waterproof material, which will keep out the moisture and germs, prevent decay, and insure speedy healing over the wound. The best raw material for this paint is pure white lead and linseed oil without turpentine, but hot grafting wax or melted pine tar will serve the purpose.

THE METHOD: The method of pruning is of very great importance. It is here that "tree butchery" in its worst form is too often exhibited. The purpose of the operator should be to make the cut in such position and in such direction as will aid the tree in most rapid healing or closing over with living wood. To do this he should remember that long stubs, allowed to remain, invariably die, and then they readily decay, start knot holes, cause hollow trunks, which continue to decay, weaken the tree, and thus insure its breaking down. The stubs of amputated limbs should be as short as possible, and the cut be made in a direction as nearly parallel as possible to the living trunk or wood. Also, the top cut should be made immediately above a living branch, rather than some distance above it, and at an angle or slope with the direction of a branch, rather than directly across or at right angles to the branch to be cut away. The distance of pruning off a branch is generally fixed at half the diameter of said branch above the terminal bud or twig which is left to grow. This has reference to the topping back of comparatively small branches. To open the head of the tree always cut to an outer bud or branch.

Where large branches are to be cut off it is best to saw from the under side to such depth as will prevent splitting and tearing off a large splinter of outer wood and bark in falling. Then, after making this under-cut, proceed to cut from above in the regular manner. If the stub be made rough and uneven it should be smoothed or sawed again and then painted. Some operators saw off the branch some distance from the trunk to get rid of the weight, and then saw off the stub nearer to the trunk in the exact position desired.

THERE ARE TWO RADICALLY DIFFERENT METHODS OF PRUNING. One can be designated as the Fruit Tree Method, in which the chief feature is to produce and maintain an open top with little dense brush and shade; and the other can be called the Shade Tree Method, in which the chief feature is to close or fill the top for the purpose of producing dense shade. By the latter method the branches are cut off at a uniform height or distance, somewhat after the manner of shingling a boy's hair, and at the upper end of each branch a bunch of shoots will subsequently appear, resulting in a thickened top and denser shade. This system will not do for fruit trees. A long branch can occasionally be shortened some distance from the trunk, but as a rule, if pruning is to be done by the Fruit Tree Method, superfluous branches should be removed by cutting as near the trunk as possible, rather than merely cutting their extremities. To make a dense or closed head, cut off a branch just above an inner bud or branch; to make an open head (best in all fruit trees), cut just above an outer bud or branch.

THE CARE OF INFECTED BRUSH. When brush is cut from diseased or infected trees, as with pear blight or plum knot, it is important that the brush be gathered and burned at once, but when the brush is infested with San José scale during its dormant season, there is no necessity of gathering and burning the brush at once so far as the scale is concerned, as this pest will never be able to free itself and pass to other trees or branches, and will die before its young appear. This knowledge may save extra work. The best place for brush not infected with true plant disease germs is in some ravine or hollow that is washing. It helps to hold the soil and prevent wash. There is no reason why brush covered with San José scale can not be used for this or any other desired purpose.

SUBSEQUENT PRUNING. If trees pruned last year require further pruning this year, it should be given them, if seriously needed. Next year, however, they will again demand attention, chiefly in the removal of many of the small shoots which are liable to occur around the stubs or upper ends of branches. About three of the strongest of each of these shoots can be left around each stub at about equal distance, to become new branches for the new top. When they become too long and twiggy, they should merely be topped, and this will cause them to branch out and aid in properly forming the top.

SUMMER PRUNING. Summer pruning is a subject of much discussion at present among fruit growers. This, in general, is not advisable, excepting to a limited degree, or for small branches or dense heads only. In pruning trees the operators should bear in mind the fundamental rule to "prune when trees are dormant to promote or increase growth, and prune when trees are in foliage to check growth." The leaves of trees perform the function of both lungs and stomach, and the products of digestion are held within the tissues of the leaves and tender branches until after the close of the growing season. To prune them while in leaf means to rob them of essential organs and the products or material produced by these organs. However, a tree often grows so rank as to produce too many twigs and leaves, which may be especially at the expense of the color and flavor of fruit. It is best to remove from such trees the superfluous branches with leaves, but in summer pruning only small branches should be cut away. Leaves commencing to turn yellow prematurely in the interior at the top indicate too much crowding by foliage, and ventilation is needed. Judicious pruning admits the air, heat and light necessary for vigor of leaf, and color and flavor of fruit. This, also, results in sturdy twigs with healthy fruit buds ready for the crop next year, rather than slender twigs with poor, starved buds which may die by winter killing.

It is also claimed that pruning about mid-summer aids in the formation of fruit buds rather than leaf buds, but if the tree has been properly sprayed and cultivated, and the fruit properly thinned, it will not be necessary to resort to summer pruning for the purpose of causing the development of fruit buds for next year's crop.

Details of the methods of pruning can be learned by attending demonstration orchard meetings held in many parts of this State, and lectures on demonstration trains as announced. No person who has trees to save can well afford to miss these demonstration meetings and train lectures. There, questions can be asked and methods illustrated, which can not easily be explained on paper without elaborate illustrations.

For those who desire to pursue the subject further, the following text books are suggested:

AMERICAN FRUITS	*Downing*
THE AMERICAN FRUIT CULTURIST	*Thomas*
THE AMERICAN APPLE ORCHARD	*Waugh*
PRINCIPLES OF FRUIT GROWING	*Bailey*
LESSONS IN FRUIT GROWING	*Goff*
PLUMS AND PLUM CULTURE	*Waugh*
DWARF FRUIT TREES	*Waugh*
THE PRUNING BOOK	*Bailey*
INSECTS INJURIOUS TO FRUITS	*Saunders*

BULLETIN 178, Office of Experiment Stations, U. S. Department of Agriculture, contains list of important references on Fruit Growing, costs 20c. Apply to Superintendent of Documents, Washington, D. C.

"FRUITS FOR PENNSYLVANIA," Funk, Bulletin 152, Pennsylvania Department of Agriculture, Harrisburg, Pa.

MONTHLY AND QUARTERLY BULLETINS, by Prof. H. A. Surface, State Zoologist, Division of Zoology, Department of Agriculture, Harrisburg, Pa.

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ORCHARD DEVELOPMENT

No. 3—SPRAYING

(Revised Edition)

To enable it to offer to its patrons in the territory which it serves, the benefits of scientific research and improvement in methods resulting from careful study and experiment, The Pennsylvania Railroad Company arranged with Prof. H. A. Surface, Economic Zoologist of the State of Pennsylvania, to prepare for distribution through its agencies, this practical treatise on "orchard development". The following pamphlet devoted to **Orchard Spraying** is one of four which may be termed "Orchard Primers", the others being devoted respectively to **Planting,** **Cultivation** and **Pruning.** Copies of all can be had upon application to the parties designated on the cover, or to the Freight Agents at the various stations.

The Pennsylvania Railroad Company has also issued pamphlets dealing with the growing of "Alfalfa", "Fertilization of land by the proper use of lime", "Seed Grain Suggestions" and "Potato Culture", copies of which may also be secured upon application to the parties above referred to.

March 1st, 1911.

SPRAYING, AND PEST CONTROL

By this term is meant applying a liquid in the form of a mist to destroy either insects or disease germs. It is necessary that the plant be entirely covered with the proper material at the right time. With a fine mist-like spray this work can be done more effectively and quickly than in any other manner. In many cases, as for example, in applying the Lime-sulphur wash for San José scale it is fully as effective in killing the scale and as safe to the trees if it be applied by throwing it over the trees in the form of a wash, or by painting it on with a brush; but the main point is to cover all parts of the tree or plant that are above ground, and generally this cannot be done in any other way than with the spray. There have been several cases of peach orchards having been saved by topping or "dehorning" the trees to short stubs on the main trunks, and then washing the entire bark with brushes dipped into the proper insecticide.

ESSENTIALS FOR SPRAYING. To do successful spraying the following points must be kept in mind: 1st. Spray for a certain kind of pest. 2nd. Spray with the right materials. 3rd. Have the materials at the right strength, or made in the right proportions. 4th. Spray at the right date. 5th. Spray in the right manner, which means thoroughly and with good and effective apparatus.

I. THE KIND OF PEST. All of the points here given depend on the nature of the pests for which the spraying is to be done, and the kinds and conditions of plants upon which they are found. The grower should know the chief pests that attack his trees, and should learn what to do for them and when to act. He can get this information by sending specimens to the Division of Zoology of the Department of Agriculture, Harrisburg; or to the State Experiment Station, State College P. O., Centre County, Pa., or to the United States Department of Agriculture, Washington, D. C. Remember that most plant pests naturally come under one of three general groups as follows: "A." Plant Diseases. "B." Chewing Insects. "C." Sucking Insects.

"A." PLANT DISEASES. Plant diseases are due to different causes, chief of which are very low forms of plant "germs" called fungi, for which the materials to be applied are called "fungicides." Among such diseases are the Peach Leaf Curl, the Leaf Spots, Black Rot of Grape, Brown or Ripe Rot of Peach and Plum, and, in fact, most of the diseases of plants, due, in general, to such causes as the Rots, Leaf Spots, Mildews, Canker and Smuts. These are incurable after once started, because the diseased tissue has the germs inside of it where they cannot be reached; but they can easily be prevented, in most cases, by spraying before the disease shows, using a properly made fungicide.

The chief fungicide is Bordeaux Mixture. This is made by using Bluestone (copper sulphate) and fresh lime in water. Two formulas are commonly used: the strong formula for hardy plants, like the potato, apple, pear and quince; and the weak formula for delicate plants, like peach and plum. The strong formula is three pounds of bluestone and three or four pounds of quicklime in fifty gallons of water. The weak formula is the same, except that it calls for only one-third to one-half as much bluestone or copper sulphate. The quicklime, or freshly burned lime, is made into a milk of lime with water, and strained into a barrel or tank holding some of the water necessary to make the Bordeaux Mixture. The bluestone is dissolved, using hot or cold water and avoiding a metal vessel, and poured into the diluted lime water, with water to make the full fifty gallons. This is a fungicide for preventing plant disease only; it is not to kill insects. It will often be used at a time when insects are to be killed, as well as to prevent plant diseases. To make it effective for this purpose arsenical poison can be added to it for the chewing insects, just as though it were added to water alone; but it is not used in any combination for the sucking insects.

Certain plant diseases are due to Bacteria rather than to fungi, and some of these cannot be prevented nor remedied by the use of fungicides or other spray materials. Among these are fire blight or pear blight, also called black blight and twig blight. This should be cut out and burned whenever seen, as no spray will remedy it. Other diseases, such as black knot of plum and sour cherry should be treated with the knife rather than with a spray. To prevent russeting of apples, the first spray for the Codling Moth, which is made just after the blossoms fall, should be made with half-strength or dilute Bordeaux Mixture, or with Lime-sulphur and the poison added.

Dilute Lime-sulphur Solution is rapidly taking the place of Bordeaux mixture as a fungicide. It is made either by diluting the boiled preparation, either commercial or home-made, five times as much as for San José scale, or making the self-boiled solution by slaking eight pounds of flour of sulphur with eight pounds of lime, and hot water enough to make it slack well for ten minutes, then adding cold water to make fifty gallons; strain and spray. Add Arsenate of Lead for chewing insects the same as to Bordeaux Mixture. For peach, dilute each Lime-sulphur formula three times as much as here directed for apple. The dilute Lime-sulphur solutions do not russet fruit.

"B." CHEWING INSECTS. Chewing insects are those like the Potato Beetle or so-called Potato "Bug," the Squash and Cucumber Beetle, and Caterpillars or so-called "Worms," which eat the tissue of the plant and thus eat and swallow any poison placed upon it. All insects feeding in this way can be killed by arsenical or stomach poisons. Chief among such are the Potato Beetles, Codling Moth and the Curculios. The chief poisons are Paris Green and Arsenate of Lead. These materials are applied only when chewing insects are present or just about to come, which means when the plants are in leaf. The usual formula is one-third pound of Paris Green or two pounds of Arsenate of Lead in fifty gallons of liquid, which may be either water or the Bordeaux Mixture. On hardy plants, like apples and potatoes, this can be made a little stronger, and on delicate plants, like peach and plum, it should be applied at half strength.

"C." SUCKING INSECTS. The sucking insect pierces the plant with its sharp beak, injects a poisonous saliva, and sucks out the modified sap, just as a mosquito attacks a person. Among these pests are the Stinking Squash Bugs, the Plant Lice and the Scale Insects. They cannot be killed by arsenical poisons, because these are placed only on the surface of the plant, and the sucking insects do not commence to feed until after they penetrate the tissues. They are to be killed by materials known as "Contact Insecticides," which kill the pests by coming into touch with them, and must be applied only when the pests are present. Thoroughness of application, in such a manner as to touch the pest with the spray liquid, is necessary.

Some of the sucking insects, such as the scale insects, are so hardy that in their mature or adult stage they cannot be killed by contact insecticides, unless so strong as to destroy the leaves of the plant. For this reason the spraying for them must be done while the trees are dormant or leafless. The scale insects are examples of this kind.

2. **THE RIGHT MATERIAL.** The right material to use for spraying depends upon the nature of the insect, the hardiness of the tree or plant, and the condition of the latter, as to whether dormant or in leaf. For all plant diseases that are to be prevented by spraying, the right material is Bordeaux Mixture, or very dilute Lime-sulphur wash. It has been proven so effective during the past season that it justifies general recommendation in definite formula. The right material for Chewing Insects is an arsenical poison, such as Paris Green or Arsenate of Lead. The right material for the Sucking Insects is chiefly the boiled Lime-sulphur wash, either homemade or commercial, for the scale insects, eggs of plant lice and other species of pests, which can be reached while the trees are dormant; and dilute oil emulsions, or very dilute soluble (commercial) oils or whale oil soap solution, or strong tobacco decoction, when the plants are in the leaf, and such pests as plant lice or young scale insects are to be killed.

TOBACCO. Tobacco is an excellent insecticide, to be used either as a strong decoction, applied as a spray or dashed against soft-bodied insects, like aphids or plant lice and young scale insects, or applied over the roots of trees infested with wooly aphis, when it should be in the form of powder, dusted abundantly on the infested spots, and then covered with earth.

3. **THE RIGHT STRENGTH.** The proper strength of Bordeaux Mixture, which is used only for plant diseases, is mentioned above, as is also that of Paris

Green and Arsenate of Lead for the chewing insects. For the scale insects and other exposed pests, when trees are dormant, the commercial Lime-sulphur can be used at the proper dilution, or it can be made at home either by boiling seventeen pounds of sulphur with twenty-two of lime, and water enough to boil at least three-quarters of an hour, then strained and diluted to fifty gallons; or it can be made in the concentrated form by boiling in the following proportions: One pound of lime, one gallon of water and two pounds of sulphur, boiling three-quarters of an hour, and add water to make up for that boiling away. Then put this concentrated solution into tight vessels and set it away to use when needed. In applying it use one part of the concentrated material in seven parts of water or use hydrometer testing not weaker than 1.03, either warm or cold. This is practically the same as the commercial concentrated Lime-sulphur which is all right and good for killing scale, if not diluted too much. It can be made by boiling with either steam, or fire under ordinary iron kettles. It need not be modified in strength for different kinds of plants. It can be used much stronger than one to seven, without injury to any plant when dormant, but it cannot be used more dilute without danger of failing to kill the scale.

The hydrometer is a very useful instrument for testing the strength of the solution. It sinks into the liquid to a given depth according to the strength, which is marked upon the scale which it carries. The Lime-sulphur solution for killing San José scale on dormant trees should not be dilute more than that which is indicated by the mark 1.03. If the instrument should sink lower than this, the liquid is not strong enough to kill the scale. It can be much stronger without any other objection than the waste of material used at increased density. In using this instrument one does not need to measure the amount of solution and water used in the spray tank, but need only test for density, and if too dilute, add more of the strong material, and then strain.

Any kind of pulverized sulphur and any kind of lime (if enough is used) will make a good solution.

The chief points in attempting to get the materials at right strength are, first, to avoid getting them so strong as to injure the plants, if a material is being used that is of such nature as may produce injury if too strong; and, second, to be sure to get the material strong enough to do the work of preventing or destroying the pests.

The right strength for kerosene emulsion as a Summer spray is about eight to ten per cent. kerosene. It is made by boiling one-half pound of hard soap with one gallon of water until dissolved, removing from the fire, adding two gallons of kerosene or common lamp oil, and beating or churning vigorously, or forcing around through the spray pump for a few minutes, until it assumes a buttery mass and thus becomes a stock solution, which can be kept and used when wanted. Then dilute with about six or seven times its bulk of water.

An easy way to make a kerosene emulsion is to add one gallon of boiling water to a gallon of sour milk, and churn or vigorously beat two gallons of common kerosene into this. This makes a fifty per cent. emulsion, which will keep, and can be reduced to a ten per cent. solution by adding one part of the stock emulsion to four parts of water.

One of the best contact insecticides for plant lice and young scale insects is whale oil soap, one pound in five gallons of water. For very delicate plants, like peach and some plums, increase the quantity of water to eight gallons, and for the hardier plants, like cabbage and potatoes, it can be reduced to four gallons.

4. THE DATE OF APPLICATION of any material depends upon the important points of the life history of the pest to be suppressed, and when it can be most effectively attacked. For the scale insects this is generally when the trees are dormant. The best time of all is just when the buds are swelling, but where there are many trees to treat, it is not safe to wait for this time. Some scale insects, like the Lecanium, which all hatch at a certain time, are best killed when the very young are present, using a properly diluted contact insecticide.

Thus, the whale oil soap, one pound in five gallons of water, applied when the young Oyster Shell and Scurfy scales hatch in May, will kill these pests. When applied more dilute for Peach Lecanium, in June, it will also have good results.

The Codling Moth is one of the worst insects of the apple, pear and quince, as it is the cause of the "wormy" fruit. For this the spraying should be done with Arsenate of Lead added to Bordeaux Mixture or dilute Lime-sulphur just after the petals or showy parts of the flowers drop, and this should be repeated in ten days or two weeks. For the chewing or sucking insects that appear during the Summer time, or when the trees are in leaf, the proper application should be made as soon as the pests appear. Thus it becomes important to treat them early, and especially while they are young or before they become numerous.

In applying fungicides for plant diseases, the two fundamental principles are to apply them before the disease becomes apparent, and keep the material continuously on the leaves and fruit during the season. To do this the application should be repeated as often as it is washed away by a hard rain, and also repeated once every two or three weeks. It is not necessary always to add insecticides to fungicides for the double purpose of destroying both pests at the one spraying, unless it be known that some insects are present or liable to occur on the plants that are being treated to prevent plant diseases.

The above are the applications that will be sure to give the best results. When reduced to the least necessary, they are: First, one spraying with strong Lime-sulphur while dormant; second, another with Arsenate in weak Lime-sulphur or Bordeaux just after the petals fall; and third, another with Arsenate in strong Bordeaux two weeks afterward. The same is true for the other pome fruits.

When weak Lime-sulphur is used for one of these last sprayings upon the leaf itself, or during the dormant period, it is an excellent preventive of injury by the leaf blister mite, which is becoming so prevalent in Pennsylvania. It also prevents most diseases of leaf and fruit, and kills plant lice and young scale insects.

FOR STONE FRUITS. The spraying for the stone fruits should start with a thorough spraying with strong Lime-sulphur while dormant, and if the trees be young, clean and vigorous, they need no further applications. Where the fruit is liable to injury by brown rot or ripe rot, spraying with the self-boiled Lime-sulphur will be helpful, if applied just after the "husks" drop, and again shortly after the fruit is half grown. To this can well be added Arsenate of Lead for the curculio of both peach and plum.

5. THE MANNER OF APPLICATION. Thoroughness is the keynote to success. The material should be applied

thoroughly, as a spray or fine mist, over all the parts of the plants to be treated, excepting the roots. In spraying for the San José scale it is necessary to spray the trees first from one side, which can be done even when there is a fairly strong wind blowing, and as soon as the material is dry, a retouching spray from the same side should be given, to be sure that no spots are missed. Next they should be sprayed from the opposite side when the wind changes, and should also be given a retouching spray from this side. This means that to thoroughly spray for the San José scale, the operator should go over his trees four times to make one good spraying. If the wind be blowing so that he cannot cover them thoroughly the first time he will have to wait until it changes to spray the opposite side. A "marker" or material like lime, added to any solution that does not leave a deposit, is very important to let the operator see a little later what spots he missed in going over them at the first spraying. About five pounds of lime to one barrel of solution is sufficient to make a good marker, although there is no objection to using more if it is properly strained. The fine sediment that goes through the strainer from the home-boiled Lime-sulphur wash is enough to act as its own marker. When the trees are dormant it is not always necessary that the liquid should be thrown in a fine spray or mist. A stream or drops will effect no injury to trees if the proper material is used. In spraying plants that are in leaf, it is very important that the pressure and nozzle be such as will throw the liquid in the form of a fine spray or mist, rather than in drops. Uniform covering of leaf and fruit is necessary. In spraying for the Codling Moth, force enough should be used to drive the spray liquid into the open ends of the little apples, and it is quite necessary that this be done just after the blossoms fall and before the green calyx tips close together at the end of the fruit. Spraying for plant lice should be done before the leaves curl and in such manner as to strike the pests wherever they occur. On low plants, like cabbage or potatoes, an up-turned nozzle on the end of a short extension rod is often needed.

APPARATUS. Spraying cannot be done without a spray pump. This is an apparatus equipped to force the liquid, generally by means of more or less air pressure, so that it will pass through a nozzle so devised that it will break into a fine mist. While a knapsack sprayer, or small hand apparatus, may do fairly well for a few low plants, or for bushes or truck, it is best to use at least a good barrel sprayer, such as will give substantial service, in an orchard. The owners of fruit trees should write to reliable manufacturers of apparatus, stating the number, size and kinds of trees they have, and they will then receive information as to what size of sprayer is best adapted to their needs. The pump should be such as will work fairly easily and give a good, strong, even, steady pressure, instead of throwing the liquid in spurts every time the handle is forced downward. It should be equipped with an agitator or some means of stirring or agitating the liquid to keep it from settling. The hose should be at least twenty-five feet in length, which is generally accomplished by fastening two sections together. An extension rod, either bamboo, lined with metal, or ordinary gas rod pipe, should be used on the end of the hose, and this should carry an eight-turn, to turn the nozzles slightly to one side. Into this should be screwed a "Y" so that at least two nozzles can be used on each extension rod. Even with the best large nozzles, it saves considerable time and consequently expense to spray with two nozzles.

The nozzle is one of the very important features of the outfit. It should be of a large, modern type, such as the "Mistry, Jr.", "The Friend", "The Brown", "The Deming" or some other of the enlarged "Vermorel" type. Some nozzles are made to throw the liquid at a slight angle, and with such the eight-turn attachment on the end of the extension rod is not necessary.

A good strainer is very important. The straining part should be made of brass wire cloth, with at least thirty meshes to the inch, built like an upright cone, or placed at an angle (not flat) in the funnel. When the liquid is properly strained and kept cleaned it will not clog the nozzle, even in spraying all day. For large trees longer hose will be needed, together with ladders for climbing into the trees, and elevated platforms on spray wagons. For large orchards a power sprayer of some kind becomes very important. The best form of sprayer next above the regular spray pump is the upright lever pump. This can be operated all day by one man, and will give plenty of power for two distinct leads of hose. Compressed air, carbonic acid gas, and gasoline engines are all commendable forms of power for sprayers. The carbonic acid gas in the gas sprayer has the one objectionable feature of undesirable chemical action of the Lime-sulphur solution, but it does not injure other forms of spray materials.

The traction sprayer obtaining power from the rotating wheels that haul the apparatus is justly coming into great favor. It is excellent for field crops and low vegetation of all kinds, and also for orchards containing trees of small to medium size.

Where for any reason, such as height of tree or length of branches, the tree which is being sprayed for San José scale cannot be thoroughly treated, it is much better to prune off that part which is not reached. No grower should be discouraged because his neighbors do not spray. If he will take proper care of his own crops he may be assured of very profitable returns. Spraying is a means of insurance of perfect fruit. The other modern features of orcharding should also be observed, especially pruning, cultivating and thinning fruits. A tree badly infested with San Jose scale cannot promptly recover without proper and severe pruning, even though it be thoroughly and effectively sprayed.

THE SPRAYING FOR AN APPLE CROP. The pome fruits, or apple, pear and quince, when in leaf, should be sprayed with stronger materials than can be applied to the drupes, or peach, plum and apricot. The winter or dormant spraying for the San José scale should be the same strength on all. This is to be regarded as the first spraying of the year for each kind. For all kinds of trees the number of applications and the kind and strength of material to use must depend upon the kinds of pests present.

On the apple, plant lice or aphids are liable to be present in injurious numbers. If so, they can be seen as very small, dark green lice on the bursting buds, if they were not thoroughly sprayed with strong Lime-sulphur solution. Whenever present they should be sprayed before the leaves curl and protect them, using one pound of whale oil soap in five gallons of water, or very strong tobacco decoction, or ten per cent. kerosene emulsion.

The next application for the apple tree should be after the buds burst and the leaves commence to expand, but just before the blossoms appear. This should be with either full strength Bordeaux Mixture, or the Lime-sulphur wash, dilute or self-boiled. If bud moths or other chewing insects be present, arsenical poisons of the usual formula should be added.

The next and most important spraying of the apple is just after the blossoms drop. This is chiefly for the codling moth, and for this purpose two pounds of Arsenate of Lead should be used in each fifty-gallon tank of water or solution. If the Arsenate alone is used, as much good fresh lime should be added to prevent burning and russetting. It can be used in half strength Bordeaux or weak Lime-sulphur. The latter is less liable to cause russetting, and is, therefore, recommended.

The next spraying should be about two weeks after the blossoms fall, using the Arsenate in Bordeaux, or weak Lime-sulphur, Summer strength. The next spraying should be about one month after this, with Lime-sulphur, Summer strength, and for the best results this should be repeated again in about another month.

For those who desire to pursue the subject further, the following text books are suggested:

American Fruits - - - - - - - - -	*Downing*
The American Fruit Culturist - - -	*Thomas*
The American Apple Orchard - - - -	*Waugh*
Principles of Fruit Growing - - - -	*Bailey*
Lessons in Fruit Growing - - - - - -	*Goff*
Plums and Plum Culture - - - - -	*Waugh*
Dwarf Fruit Trees - - - - - - -	*Waugh*
The Pruning Book - - - - - - - - -	*Bailey*
Insects Injurious to Fruits - - - -	*Saunders*

Bulletin 178, Office of Experiment Stations, U. S. Department of Agriculture, contains list of important references on Fruit Growing, costs 20c. Apply to Superintendent of Documents, Washington, D. C.

"Fruits of Pennsylvania," Funk, Bulletin 152, Pennsylvania Department of Agriculture, Harrisburg, Pa.

Monthly and Quarterly Bulletins, by Prof. H. A. Surface, State Zoologist, Division of Zoology, Department of Agriculture, Harrisburg, Pa.

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ORCHARD PRIMERS

No. 4

CULTIVATION

(Revised Edition)

By
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Approved by
Hon. N. B. Critchfield
Secretary of Agriculture, State of Pennsylvania

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March 1st, 1911

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ORCHARD DEVELOPMENT

No. 4.—CULTIVATION

(Revised Edition)

To enable it to offer to its patrons in the territory which it serves, the benefits of scientific research and improvement in methods resulting from careful study and experiment, The Pennsylvania Railroad Company arranged with Prof. H. A. Surface, Economic Zoologist of the State of Pennsylvania, to prepare for distribution through its agencies, this practical treatise on "orchard development". The following pamphlet devoted to **Orchard Cultivation** is one of four which may be termed "Orchard Primers," the others being devoted respectively to **Planting, Pruning** and **Spraying.** Copies of all can be had upon application to the parties designated on the cover, or to the Freight Agents at the various stations.

The Pennsylvania Railroad Company has also issued pamphlets dealing with the growing of "Alfalfa," "Fertilization of land by the proper use of lime," "Seed Grain Suggestions" and "Potato Culture," copies of which may also be secured upon application to the parties above referred to.

March 1st, 1911.

CULTIVATION OF THE ORCHARD

The two great problems of the orchardist as well as the general agriculturist of today are (1) the preservation of soil-fertility, and (2) the conservation and utilization of soil-moisture. Soil-fertility is by far better to be obtained by the growing of proper manurial crops, than by the addition of commercial fertilizers or other forms of manure. The best cover crops and soiling crops to enrich the soil are the legumes, especially crimson clover, cowpeas, soy beans, vetch, and other clovers. Orchardists will find it cheaper and better to grow this fertility on their soil, rather than to be obliged to add it. Where forced to derive an income from crops grown between trees, it is possible to do this, but it is better for the trees and the soil, which means the present and future welfare of the orchard, to grow a leguminous cover crop to furnish plant food for the trees, rather than to grow cultivated crops to furnish an immediate income for the farmer.

The chief purpose of the cultivation of the orchard should be the welfare of the trees, rather than for any crop that may be grown between them. Where possible to grow a cultivated crop between the rows without injury to the trees, there is no greater objection to this than the fact that it decreases rather than increases the soil-fertility that should be reserved to make peaches worth three dollars per bushel, or apples worth four dollars per barrel. No treatment is too good for an orchard, as it will in the due course of time produce returns far greater than any ordinary farm crop, or than almost any other crop that can be produced from the same soil. The cultivation should be for the sake of the trees themselves. Thus, the cultivator should bear in mind that it is better to plow out a few hills of potatoes which may be out of line, than to run his implement over against the tree-row so far as to result in injury to the trees.

The cultivation of the orchard should commence immediately after planting. The rows of trees should be cultivated with the same faithfulness, and in practically the same manner, as corn or potatoes, and after every packing rain the soil should be stirred or cultivated and kept loose for the chief purpose of saving the soil-moisture, and also destroying the weeds. This cultivation should continue until the terminal buds are formed in the latter part of Summer or early part of Fall, or in other words, until growth ceases. The fruit grower must recognize that his fruits consist chiefly of water, and that they cannot grow, fill out, and become perfect, without this necessary element. He should know that for the water for making perfect fruit he must depend, not upon the rainfall of the Summer, but upon the rains of the previous Winter. To do this he must cultivate in such a manner as to save the soil-moisture, and make it available at the time when most needed by the trees and their fruits.

INTER-CROPS: While trees are young there is no reason why cultivated crops cannot be grown between them. The best crops for this purpose are those that are low and need frequent early cultivation. There are none better than early potatoes, cabbage, peas and beans, but in extensive orcharding it sometimes becomes advisable to grow corn. Sweet corn is better than field corn, for the chief reason that it matures earlier and does not grow so large; but between trees during the first year, and sometimes also during the second year, field corn can be grown without serious detriment to the life and growth of the trees, if the farmer be careful to bear in mind that that field is given primarily to the growing of trees rather than of corn, and that the corn rows should be kept far enough from the trees to give the latter plenty of air, sunshine, heat and moisture, without any crowding. Potatoes are better than corn to grow in a young orchard after the first year, and these can be continued in a peach orchard until the third year or twice as long in an apple orchard if economy should demand it. In an orchard that is strictly given to apples and pears, cultivation of certain low crops like potatoes, peas, beans, and vegetables, can continue even during the fourth and fifth years without serious injury to the trees, if plant food be added to make up for that which is removed by the plants which were grown by the soil during this same period. It is better in the cultivation of trees and also crops in orchards, to change the direction of cultivation every year, so that the ground will be thoroughly cultivated in rows at right angles during every other season.

Certain crops, such as hay, should be avoided in the orchard unless this is to be grown purely for the purpose of mulching the trees with the grass product. This is the sod mulch system, and is recommended for older apple and pear trees, but not for peach. It is possible to grow cereal crops of any kind between young trees by drilling the grain with one round of the drill between the tree-rows leaving space enough for the cultivator to pass and keep the ground cultivated between the grain and the trees. Some of the rye grown by the writer last year was thus produced in a two-year-old peach orchard, following potatoes which grew between the trees their first Summer. However, the trees themselves were kept cultivated; and as soon as the rye was removed the entire orchard was well torn up with the disk harrow, and crimson clover was sown thereon.

Cover crops, such as crimson clover, soy beans, cowpeas, vetch, and even the other clovers are important and valuable for an orchard, but they should not be sown broadcast and left to grow in this manner until their full maturity. It is right and proper to sow a cover crop, especially such as crimson clover, in midsummer, or buckwheat a little later than midsummer, and to leave this, without cultivating the tree-rows, until early Spring. This crop thus forms a cover crop during Winter, which helps to preserve the nitrates and other soluble elements of soil fertility, and also prevents washing and leaching. In the early Spring, as soon as the ground is dry enough to cultivate properly, the cultivator should start in the tree-rows, regardless of the broadcast cover crop, part of which it must tear up in this first cultivation.

An important difference in the care or cultivation of peach and plum orchards on the one side, and apple and pear on the other, is that the former should be kept cultivated all the time, or in other words, they never get so old that they should be allowed to go to grass without cultivation; while it is possible to sod down the apple or pear orchards and obtain good results by the sod mulch system, which consists of mowing the grass crop and leaving it on the ground or throwing the mowings beneath the trees as mulch. This should, of course, extend at least as far as the branches of the trees or somewhat farther, and serves the important purposes of keeping down the weeds, preserving the moisture, keeping the roots cool and ventilated in Summer and warm in Winter, and particularly acting as a soft cushion for fallen fruits, which often may be gathered without bruises and sold at a much better price than if they had dropped upon firm ground. After the third or fourth year the cultivation of the peach orchard should be chiefly with the disk (or cut-away) and spike harrows, and it is not advisable to attempt to grow any other crop between the bearing peach trees. Also, this is not needed, for if a peach tree four years old has not commenced to give returns enough to its owner to encourage him and to show him that it will be its own justification and source of profit, there is something radically wrong, or a period of two unusually unfortunate seasons in succession has occurred.

It is a great mistake to place the orchard on the poorest, stoniest and washiest hillside upon the farm, and then expect it to thrive marvelously and to give ten times as much returns as are to be obtained from good fields, well tilled and well fertilized, yet this is often done. Where there is a hillside that is to be utilized, this can be done by making partial terraces and planting thereon apple, pear or cherry trees, and sowing the soil with clover or some other leguminous crop, using lime and fertilizer spread broadcast over this soil to insure growth of clover, or a cover crop, and mowing the vegetable growth, using it as a mulch around the trees. One objection to the mulching of trees is the danger from mice, but this can be easily overcome by surrounding the trees with a collar of heavy, galvanized wire netting of one-fourth inch mesh, sunken well into the ground. Hillsides that cannot be cultivated without considerable washing and loss of fertility should not be planted in peach trees, as these should be kept in cultivation. One advantage of planting pear trees in such a place is that this is where trees grow slowly and the slower the pear trees grow the less subject are they to that most fearful and dreaded disease of the pear tree known as the pear blight. By reducing the amount of mulching or cultivating the rate of growth of the tree is checked or reduced. Terracing, at least with spade and hoe around the tree as far as the branches extend, will form a good spongy bed for the retention of moisture and the growth and life of the roots. With deep, good soil, well terraced at the lower side of the tree, and kept mulched, the growth will be at least moderate and the bearing will be satisfactory. One of the most productive and profitable orchards in the eastern United States is on a hillside, and conducted by this system. Much more is to be said upon the subject of fertilization and cultivation of orchards, but we here touch on these subjects only in relation to giving vigor to the trees, helping them to outgrow the stunting effects of the scale and other pests, and making them profitable, whereas otherwise they would become but fit subjects for the brush pile.

IMPLEMENTS FOR CULTIVATION. The breaking of the ground, or plowing, can be done with a good plow such as the Oliver Chilled. It is a good plan at the time of turning the soil in an orchard in the Spring to plow in such a way that the earth is thrown to every other tree-row. This is the same as making a tree-row in the middle of each "land" and will, of course, throw the soil away from every other row. This should be cross-harrowed with a spring-tooth harrow. In fact, the planting of the crop should be so that it will be across the ridges and depressions this year. Next year, in plowing or breaking the soil, plow the field in the same direction, but throw the dirt to those rows from which it was turned away this year, and turn it away from those toward which it was previously thrown.

A one-horse plow, commonly called a "bar shear," is a good implement for plowing the first two rounds adjacent to the tree-row. It does not need to be plowed so deeply here, and in fact, it is better for the trees to plow the first two rows shallower. A single horse pulling the plow will not crowd so closely to the trees, and consequently, not be so likely to injure them as will a double team. After the first two furrows in the middle of each round are turned with a single plow and horse, the others can, of course, be turned with a regular double team and breaking plow.

The spring-toothed harrow is valuable in its place, but care should be taken not to run it to such a depth as to tear up the roots of the trees. Where the ground is plowed in the Fall, a spring-toothed harrow is good to loosen it up in the early Spring, but it is better to leave the cover crops on the ground during Winter and plow very early in Spring.

The disk harrow is one of the best implements that can be used in the orchard. It can be so spread as to cultivate under the trees without crowding them so closely with a team as to injure them. It partially turns the soil, and thus effectively kills the grass and weeds, and even often tears out such obstinate plants as the wild carrot. It loosens the soil to the proper depth, and thus forms the loose soil mulch which helps to retain moisture. When the operator learns to set each of the two sides of the disk harrow at the proper angle, he can do good work on the hillside ground. Experience will be his teacher here. Where the soil is very stony the disk harrow will be found unsatisfactory, but it is better to pick and haul stones from such places. The double disk is better, as it does not leave a ridge.

The one-horse cultivator is a good implement for both orchard and field cultivation. It is not necessary to keep the soil cultivated to any great depth. Three inches is sufficient depth for cultivation. Frequency of cultivation is more important than greater depth. Those cultivators which can be adjusted in width have an advantage over others, in the fact that their shovels or teeth will not fall in the same furrows as before, and will keep the soil well broken.

Hand cultivation under each tree is likely to become quite desirable. Of course, the weeds and grass should never be permitted to grow under a tree that is to be cultivated. Some attention to this with the hand hoe may be needed in the Spring time, but as one of the chief purposes of cultivation is the retention of soil-moisture, and as this is best done by continually breaking up the crust of earth which forms after a rain, it can be seen that some hand work with a hoe under each tree between the trunk and the furrow of a plow would be beneficial in helping to break up the crust and retain the moisture.

MULCHING. The use of a mulch in an orchard can certainly take the place of cultivation to a very great extent. By a mulch is meant a cover of organic material such as strawy manure, straw or other litter, leaves, grass, hay, etc. A fine mulch is better than coarse for retaining moisture, and more readily furnishes plant food. The mere spreading of a little loose straw around a tree is not to be regarded as mulching. The mulch, to be effective, should be so thick that it will practically prevent the growing of grass and weeds, and will keep the soil damp and loose, as is to be seen where the leaves are deep in a forest; and, in fact, the purpose of a mulch is to produce just such condition as may be seen in a good virgin forest where the leaves are deep.

If the orchard needs plowing, as shown by the hard soil, sparse growth, and short twig development of the trees, it is advisable to plow it in the early Spring, adding some commercial fertilizer containing phosphoric acid, potash, and nitrogen, sown broadcast over the ground. If stable manure is available, it is excellent, and can be used before plowing to an extent of ten or twelve tons to the acre. The soil should then be harrowed to level it, and if the plan is to mulch it, the mulch can next be added in sufficient quantity to serve the desired purpose.

The plan of sod mulching, or mowing the grass and throwing it around the trees twice as far as the branches extend, is very good if there be enough vegetation to make a real mulch.

Orcharding can be very successfully conducted on quite hilly land by the terracing method, and on very stony ground by use of the hand hoe and abundant mulch. However, if one does not have material to use as a mulch, it is far more important to cultivate the orchard than to let it merely grow in grass and weeds.

Mulching can well be done in the Fall, with a view of covering the roots and protecting them from later injury in Winter. For peach and plum trees this is an important point, as much of the damage to those trees comes from this cause. It is believed by some careful observers that the disease known as peach yellows, for example, arises from Winter injury to the trees, especially to the roots. If this can be prevented by mulching, it becomes very important.

TO PREVENT INJURY BY MICE. A winter mulch attracts mice or moles, which may do considerable damage by gnawing the bark of the trees and their roots. This can be prevented by the following means: (*a*) Place a band or collar of wire netting around the tree, extending down into the ground. (*b*) Protect the tree with tarred paper or a bar of wood veneer. (*c*) Tramp the snow so it is packed around each tree before the mice commence their work. They will not feed beneath nor on the packed snow. (*d*) Poison the mice with a little strychnine bait put in their holes. (*e*) Protect their natural enemies such as cats, hawks and owls. (*f*) Train terriers or beagles to hunt them. (*g*) Practice absolutely clean cultivation during all the year excepting late Fall and Winter.

Where a mulch is not possible for trees during the Winter, it is at least advisable to prepare the soil under them by filling it in such a way that water will not stand in pools over their roots. It is better to throw enough soil towards the trees in the Fall of the year to give a gradual slope from the trunks. This will provide drainage during the Winter, and help to prevent the freezing of water at their roots.

RENEWING THE PEACH ORCHARD. Too many persons make the mistake of renewing the old peach orchard, which needs only proper treatment to make it again valuable. This treatment in brief is as follows:

Cut it back to stubs, not more than three or four feet from the ground, before the buds burst. Remove and burn the brush, and spray or wash the stubs thoroughly with strong Lime-sulphur solution. Fertilize it well with a nitrogenous fertilizer, such as ten tons of stable manure, or a complete fertilizer carrying three hundred pounds of nitrogen to the acre. Plow or harrow the ground, and cultivate it again and again in each direction, until it is in a good state of cultivation. Then keep cultivating with a harrow once a week in each direction.

A good plan for renewing an old bearing peach orchard is to top back or "dehorn" every other row. Let the alternate rows bear their crop this year. The topped rows will grow new tops under the stimulus of proper fertilization and cultivation, and will set fruit buds abundantly for next year's crop. At the next dormant season top back the alternate rows, properly thin the superfluous twigs and branches from those that were previously topped, and tip the longer shoots, without removing too many fruit buds. This will give a crop during each year, and is especially desirable where all the trees have become so large as to crowd each other and render it a problem as to what should be done next year with the tall, crowded trees. It may, in some cases, be advisaple to permit two years to elapse between the topping of the two rows. This will result in tops as vigorous and fruitful as any found in young orchards, if followed by proper horticultural care.

For those who desire to pursue the subject further, the following text books are suggested:

AMERICAN FRUITS - - - - - - - - -	*Downing*
THE AMERICAN FRUIT CULTURIST - - -	*Thomas*
THE AMERICAN APPLE ORCHARD - - - -	*Waugh*
PRINCIPLES OF FRUIT GROWING - - - -	*Bailey*
LESSONS IN FRUIT GROWING - - - - - -	*Goff*
PLUMS AND PLUM CULTURE - - - - -	*Waugh*
DWARF FRUIT TREES - - - - - -	*Waugh*
THE PRUNING BOOK - - - - - - - - -	*Bailey*
INSECTS INJURIOUS TO FRUITS - - - -	*Saunders*

BULLETIN 178, Office of Experiment Stations, U. S. Department of Agriculture, contains list of important references on Fruit Growing, costs 20c. Apply to Superintendent of Documents, Washington, D. C.

"FRUITS OF PENNSYLVANIA", Funk, Bulletin 152, Pennsylvania Department of Agriculture, Harrisburg, Pa.

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